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A Times Investigation

‘Dirty bomb’ matter in our midst

Medical devices containing radioactive cesium remain widely used across the U.S. despite increasing risk.

By David Willman and Melody Petersen

SEATTLE — Scientific experts warned Congress more than a decade ago that just four teaspoons of radioactive cesium-137 — if spread by a terrorist’s “dirty bomb” — could contaminate up to 10 square miles of Manhattan.

The material is commonly found across the United States. Hospitals, blood banks and medical research centers use it in devices called irradiators, which sterilize blood and tissue. Hundreds of the devices are licensed for use, including at least 50 in Southern California.

Each typically contains about twice as much radioactive material as the scientific panel warned could disrupt much of the nation’s largest city.

The panel’s warning in 2008 came with blunt recommendations: The government should stop licensing new cesium-based blood irradiators, and existing ones should be withdrawn from use. Safer devices that use X-ray technology worked just as well, the panel found.

But afterprotests from hospitals, the U.S. Nuclear Regulatory Commissiondeclined to crack down. Instead, the number of licensed irradiators used for blood — and the risk they pose — has grown, a Los Angeles Times investigation shows.

Recent emergencies highlight the danger.

Pennsylvania authorities in 2015 intervened after an improperly securedirradiator was found inside a downtown Philadelphia office building nearthe planned motorcade route for a visit by Pope Francis.

In May of this year, the accidental release of a small amount of cesium from an irradiator in Seattle contaminated 13 people and caused a seven-story medical research building to be shuttered indefinitely.

The cesium used for irradiators is a dry, talc-like material derived from atomic fuel left over from nuclear power production.

The material is particularly feared by experts on radiological threats because its fine particlesdisperse easily and can migrate through air ducts and bind tightly to porous surfaces, including concrete. The potential danger is long-lasting: Cesium can keep emitting radiation for nearly 300 years.

“The amount of cesium in one of these irradiators is enough to contaminate and create widespread panic over an extremely large area if dispersed by a terrorist,” said Leonard W. Connell, a nuclear engineer who was among the scientific experts who issued the 2008 recommendations.

Since those recommendations, several developed countries have converted away from cesium. The Nuclear Regulatory Commission, by contrast, has not only continued to license new irradiators, it has also declined to require users to post financial bonds that would guarantee proper handling and eventual disposal of the material. Suchperformancebonds are mandatory for utilities licensed to operatenuclear power plants.

In a memo to the commissioners on April 7, 2016, the commission’s top staff official, Executive Director for Operations Victor M. McCree, wrote that financial assurance requirements “should be expanded” to include

cesium irradiators and other similarly significant sources of radiation.

The commissioners have not acted.

The Times interviewed more than 50 current and former government officials, along with medical industry specialists and other technical experts and examined thousands of pages of state and federal records to study the risk posed by cesiumirradiators.

A dirty bomb packed with cesium would not kill a large number of people. Instead, it would be a weapon of "mass disruption" — leaving areas uninhabitable for months or even decades and increasing long-term cancer risks for people who come in contact with it, atomic experts say.

Though a dirty bomb has not been successfully detonated, terrorists have voiced keen interest in doing so. For instance, in 2011 an extremist named Anders Breivik, who killed 77 Norwegians with a fertilizer bomb and firearms, released a manifesto in which he called for followers to help him acquire cesium and other components "to construct and detonate a radiological bomb."

Federal law gives the NRC broad authority to restrict the use of cesium and other radioactive materials to safeguard national security "or to protect health or to minimize danger to life or property."

The agency, however, has declined to take action to limit the irradiators, citing a low likelihood of immediate deaths or other physical harm. In doing so, the commission has looked past the mass evacuations, business closures and other economic losses that a dirty bomb could cause.

Last year, a federal task force headed by the chair of the NRC concluded that no basis existed for more than voluntary incentives to encourage users to switch away from cesium irradiators.

As Chair Kristine L. Svinicki wrote in an Oct. 17, 2018, letter to President Trump, "the Task Force concluded that there are no significant gaps in … radioactive source protection and security that are not already being addressed."

Svinicki declined through a spokesman to answer questions for this article, as did each of the other three sitting NRC commissioners, all of whom are appointed by the president.

Stephen G. Burns, a former commissioner whose tenure ended on April 30, said the NRC had sought to balance public safety with the interests of the facilities using the devices, notably hospitals wary of the commission "regulating the practice of medicine."

The NRC's stance toward regulating cesium contrasts with public warnings about radiological-weapon threats issued by every presidential administration since the Sept. 11, 2001, attacks.

Trump, in his own 2017 National Security Strategy report, warned that the threat of a dirty bomb "is increasing."

In a series of investigative reports, the U.S. Government AccountabilityOffice has challenged the commission's assurances that no meaningful "gaps" exist in how cesium and other radioactive materials are secured.

In 2012, a GAO report described finding a cesium irradiator on an unsecured wheeled pallet near a hospital's loading dock. At a second facility, investigators found the combination to a lock — intended to secure a cesium irradiator — "clearly written on the door frame."

The GAO's most recent report, issued in April, implored the regulatory commission to act more forcefully. David C. Trimble, the analyst who supervised the GAO's work, recalled that each time his staff has examined uses of cesium and other radioactive materials, "we have identified a vulnerability."

"We hope that [the] NRC will recognize the significance of the Seattle incident, and reassesses its position to not consider socioeconomic costs," Trimble told The Times.

The U.S. Department of Energy has also diverged from the NRC's hands-off stance. The department has worked with users and manufacturers to harden the devices against theft.

In2015, the department started giving incentives to convert to safer technologies, offering to pay 100% of the expense to remove and dispose of any cesium irradiator, which typically cost up to $200,000 per unit. The department says 108 of the devices have been replaced. Its announced goal is to "permanently eliminate" cesium irradiators by 2028.

"Every irradiator that is replaced represents one fewer opportunity for a terrorist," the department said in a report to Congress in April.

But, the report added, the "voluntary nature" of the conversions "remains a challenge" to hitting the 2028 goal.

In February 2018, University of California Chancellor Janet Napolitano called for the 10-campus system to begin converting away from its cesium irradiators.

Yetdespite those steps, the number of licenses that the NRC has issued for operating cesium irradiators for sterilizing human blood has actually grown: The 370 nationwide represent an increase of 4% since 2011, according to statistics provided to The Times by the commission.

"We were surprised," Margaret Cervera, a health physicist at the NRC, said of the increased numbers. "We expected them to be going down."

The total may be larger. Cervera and a commission spokesman, David McIntyre, said the 370 leaves outirradiators that the commission suspected were being used for animal experiments or other research, rather than sterilizing human blood. In April, the Department of Energy reported to Congress that an additional 315 cesium irradiators were being "used primarily for research irradiation."

A strange, glowing material

Evidence of the damage cesium could cause emerged tragically in 1987 in Goiania, Brazil, an interior city about 800 miles northwest of Rio de Janeiro.

In September of that year, two people entered an abandoned site that had once housed a radiation-therapy clinic that utilized cesium.After prying loose some of the metal equipment, they loaded it into a wheelbarrow, hoping to sell pieces as scrap.

That evening, both men began to vomit. It wasn't until two weeks later — after the equipment and the strangely glowing material inside it had changed hands through two scrap yards and become a source of fascination for adults and children — that a local physicist persuaded authorities to take action.

A monitoring station set up in a stadium screened more than 112,000 people for possible cesium contamination. Forty-nine houses were demolished or decontaminated and about 4,500 tons of soil were hauled away, according to the International Atomic Energy Agency.

In the end, four people died and hundreds had to be decontaminated.

Soon thereafter, the breakup of the Soviet Union increased the availability of radioactive materials at military facilities that had become neglected.

As a nuclear engineer and former CIA intelligence officer, Warren Stern traveled to the former Soviet republics, seeking to secure loose materials that could have fallen into the hands of terrorists. By Sept. 11, 2001, he was uniquely positioned to warn the U.S. government about the potential of a dirty bomb.

That night, after the attacks on the World Trade Center and the Pentagon, Stern and a colleague began composing an urgent memo to their boss, Secretary of State Colin L. Powell, describing this new terrorist threat.

In 2002, Stern joined the staff of then-U.S. Sen. Hillary Clinton (D-N.Y.) as a nuclear advisor and

persuaded her to try to force the NRC to phase cesium out of circulation and to seek tighter controls on other radioactive materials.

The effort was quickly scaled back in the face of opposition from other senators. But that year, Clinton introduced a bill calling for the National Academy of Sciences to study whether any uses of radioactive materials — including cesium — could be replaced with effective and safer alternatives.

In 2005, the call for a study became law, and in 2008, the National Academy's appointed experts sent their report to the NRC and Congress. They ranked cesium as their top concern.

Cesium irradiators "should be replaced," the 219-pagereport said, adding that effective and safer X-ray irradiators "are already commercially available as substitutes."

The experts directed an additional message to the NRC, saying it "should discontinue all new licensing and importation of these [cesium] sources and devices."

Users objected, citing concerns about the costs of switching and questioning whether the X-ray technology would be as effective.

Among those who spoke out was Thomas M. Priselac, president and chief executive of Cedars-Sinai Medical Center in Los Angeles. Without its cesium irradiator, Priselac said in an Oct. 14, 2008, letter to the NRC, Cedars might be unable to reliably irradiate high volumes of blood, possibly compromising patient safety.

A Cedars spokesman declined to say whether the cesium irradiator remains in use today.

"What I can say is that Cedars-Sinai has strict policies and procedures in place governing the use and management of irradiation technology," the spokesman, Duke Helfand, wrote in an email. "This oversight has been reviewed and approved regularly by state and federal regulators."

The NRCdeferred the National Academy panel's recommendations and called for further study.

In an interview, Theodore L. Phillips, chairman of the panel, said he and his colleagues — including a senior American Red Cross blood-transfusion specialist — found the evidence for converting away from cesium to be overwhelming.

"There are X-ray irradiators that do blood irradiation with no problem," said Phillips, a physician who for 29 years headed the radiation oncology department at UC San Francisco.

The committee's conclusions, Phillips said, were influenced by studies showing the severe impact that small amounts of cesium could cause.

Cesium irradiators typically contain material amounting to about 2,000 curies, a measure of radioactivity. Scientific "vulnerability assessments" performed by the Sandia National Laboratories and provided to the committee showed that a bomb with 1,000 curies, aboutfour teaspoons of cesium, could contaminate up to 10 square miles of Manhattan if dispersed uniformly. Just 40 curies could contaminate an urban area of up to 267 acres. Members of Congress and their staffs were briefed on the details.

The committee's report also cited a 2005 study of theoretical dirty bomb attacks on the ports of Los Angeles and Long Beach. The study, paid for by the Department of Homeland Security, estimated cleanup costs and business losses ranging to more than $100 billion.

Reached recently, Connell, the nuclear engineer who was a member of the committee and who had led Sandia's studies, said any inconveniences of switching away from cesium irradiators should be weighed against the potential for harm.

"We simply cannot permit a large, successful dirty bomb attack involving cesium to occur," Connell said in an email. "There is no longer any reason to keep cesium irradiators in our hospitals and universities right in the middle of our major cities."

'A risk to public health'

From its offices in downtown Philadelphia, Avax Technologies Inc. was aiming to develop treatments for cancer — work that utilized a cesium irradiator.

But Avax fell into financial distress and as of 2014 had "essentially ceased operation," said Terry J. Derstine, a radiation program manager for the Pennsylvania Environmental Protection Department. By May 2015, the company had stopped paying its rent, according to state government records.

On the afternoon of May 27, Derstine's colleagues inspected the site after learning the landlord had shut off power to Avax's offices, which disabled door alarms intended to buttress 24-hour security for the irradiator, kept inside its own room.

The irradiator "was no longer being maintained in a secure manner … and was liable to theft, removal or improper usage, consequently posing a risk to public health and safety through radiation exposure," according to a formal summary of facts, signed by Avax's director of regulatory affairs and by Derstine and another state official.

The landlord restored power to the room on the afternoon of the inspection. In August 2015, state officials agreed to allow Avax to keep the device on condition that the company post a $200,000 bond to cover expenses if more trouble arose. Derstine and his colleagues also alerted city police and the FBI's Philadelphia field office.

The irradiator was a matter of high concern, Derstine said, because the city was preparing for the visit of Pope Francis, whose motorcade would travel along Benjamin Franklin Parkway, just two blocks from Avax's offices.

Earlier this year, Derstine told NRC commissioners that if a terrorist had set loose the cesium, "many people could have easily been exposed."

The pope's visit went uninterrupted. But on May 3, 2016, state officials learned that Avax "was no longer capable of continuing operations," regulatory documents show.

"Several of the security measures that were in place to protect the irradiator were in jeopardy of being terminated by the supplier for lack of payment," Derstine told the NRC.

This time, Philadelphia was preparing for a second major event — the Democratic National Convention. Soon afterward, state officials forced the removal of the irradiator.

In an interview, Henry E. Schea III, who was Avax's regulatory affairs director and its radiation safety officer, acknowledged the company had been in "arrears in paying its rent" but said the irradiator had not been jeopardized.

In interviews with The Times, Derstinerecalled the ordeal, which has not previously been publicized.

"Over the last 30 years," the incident "was probably the No. 1 thing we've had to deal with," he said.

Tiny spill, huge disruption

Technicians confirmed the accidental release of cesium from the irradiator in central Seattle about 9:30 p.m. on May 2.

A company had been hired to remove the device, used for years in experiments on animals performed by University of Washington researchers. But while the technicians were preparing the irradiator to be loaded for transport, they nicked its protective metal shielding, causing a breach.

Thirteen people were contaminated with non-life-threatening levels of cesium: eight technicians who'd been trying to remove the irradiator, a building custodian and a radiation safety officer assigned to oversee the removal, two inspectors with the state health department and an FBI agent who wound up with cesium in his hair.

What unfolded that night — and over the months that followed — demonstrates the disruption caused by even a tiny, unintentional release of cesium, according to interviews with those involved and The Times' review of local, state and federal documents.

Seattle Fire Department specialists at first struggled to figure out how to decontaminate those who'd been inside the seven-story research and training building.

Across the street, at the university's Harborview Medical Center, emergency room managers — fearing that cesium could be tracked into the hospital — initially denied entry to those needing treatment.

A supervising state health physicist, Mark Henry, along with officials from the Fire Department and the National Guard, persuaded the hospital to relent. A barrier could be made from thick sheets of plastic, heavy paper and plenty of tape to protect staff and other patients, they explained.

"Hospitals aren't used to dealing with radioactive contamination," said Mikel J. Elsen, the Washington health department's director of radiation protection, who commented alongside Henry and other state officials in Tumwater, Wash.

The testing of all 13 individuals found their contamination levels "did not pose a health risk to any of those individuals or the general public," according to a university medical school spokeswoman, Susan Gregg.

But more than seven months later, sections of six of the seven floors of the building remain off-limits because of lingering cesium.

Officials believed an elevator near the breached irradiator spread the cesium with "piston-like" effect. Once it entered the main ventilation system, they said, it scattered more widely.

Hand-held instruments found cesium within the drywall and in other difficult-to-reach nooks and crannies.

The heaviest concentrations were around the loading dock where the irradiator had been positioned; officials pointed to a portion of the concrete surface of an adjacent parking area that also was contaminated.

The Energy Department is investigating to assess "the root cause of the accident," according to a spokesman, Gregory A. Wolf, who said the department spent about $8.6 million for the cleanup through Sept. 30.

No date has been set for when the building might be restored to its previous uses.

"This has been the worst contamination event we've had in this state in the public domain," said Elsen, the state health official. "And it could have been much worse, because that's a lot of cesium if it all got out."

Henry, the state health physicist, called the event a foreshadowing of what a dirty bomb could do.

"If you think that somebody couldn't get ahold of material like this and make a weapon of mass disruption, then I think you need to review that again," Henry said. "You can see the consequences right now. You've got a dead building."

Times staff researcher Scott Wilson in Los Angeles contributed to this report.